SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. Derive the expression for the nuclear magnetic dipole moment and explain its significance. How do magnetic dipole moments provide insight into the structure of nuclei, especially in odd-A nuclei? Provide relevant examples.

17. Discuss Gamow's theory of alpha decay. Explain how quantum tunneling is used to describe the escape of alpha particles from the nucleus.

18. Explain the mass parabola and its significance in nuclear stability. Using the mass parabola, describe how the stability of isotopes can be predicted, particularly for beta decay and fission processes.

19. Explain the principles and applications of neutron activation analysis (NAA) and Rutherford backscattering spectrometry (RBS). Discuss how these techniques are used for material composition analysis and their advantages over other analytical methods.

20. Derive the Gell-Mann—Nishijima formula and explain its significance in understanding the relationship between charge, baryon number, and isospin. How does it help in classifying and predicting the properties of hadrons?

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APRIL/MAY 2025

GPH32/DPH32 — NUCLEAR PHYSICS

Time : Three hours Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. What is nuclear angular momentum and how is it quantified?

2. What is isospin and how does it relate to nucleons?

3. What is the Q-value in alpha decay and how is it calculated?

4. Why is the beta decay energy spectrum continuous?

5. What is the semi-empirical mass formula in the liquid drop model?

6. Define nuclear isomerism.

7. Define pulse shape and its relevance in radiation detection.

8. What is an ionization chamber and how does it detect radiation?

9. What are nucleons? Give examples.

10. List the four fundamental forces in nature.

SECTION B — (5 × 5 = 25 marks)

Answer ALL questions.

11. (a) Discuss the role of parity in nuclear physics and give examples of how parity conservation can be observed in nuclear reactions.

Or

(b) Describe the ground state properties of the deuteron, including its binding energy, spin and parity.

12. (a) What are the selection rules for alpha decay and how do they affect the decay process?

Or

(b) Explain scattering cross-sector of nuclear reactions.

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13. (a) Explain the key assumptions and conclusions of Bohr-Wheeler's theory of fission.

Or

(b) Describe the square well potential and its use in the shell model. What are the limitations of this potential?

14. (a) What is energy resolution in radiation detectors? How is it measured and why is it an important parameter in detector performance?

Or

(b) Explain the operation of a Geiger-Muller counter. How does it detect radiation and what are its limitations?

15. (a) Explain the classification of hadrons into baryons and mesons. Provide examples of each and describe their properties.

Or

(b) Explain the significance of the Higgs particle in the Standard Model. How does the Higgs mechanism provide mass to other fundamental particles?